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# CERTIFICATE

This certificate is issued in support of an application for Patent registration in a country outside New Zealand pursuant to the Patents Act 1953 and the Regulations thereunder.

I hereby certify that the annexed is a true copy of the Provisional Specification as filed on 13 March 1998 with an application for Letters Patent number 329800 made by Rocktec Ltd.

Dated 10 May 1999.

**PRIORITY DOCUMENT**
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Neville Harris

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Commissioner of Patents

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**PATENTS FORM NO. 4**
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**PATENTS ACT 1953**
**PROVISIONAL SPECIFICATION**

IMPROVEMENTS TO ROCK CRUSHERS

WE Rocktec Limited, Mangawhero Road, Matamata, New Zealand, a New Zealand company

do hereby declare this invention to be described in the following statement:

IMPROVEMENTS TO ROCK CRUSHERS

## TECHNICAL FIELD

This invention relates to improvements to rock crushers.

In particular, the present invention relates to improvements in finishing crushers. Reference to finishing crushers should not be seen to be limiting the scope of the present invention's manufacture or use, as the principles of the present invention may be applied to other applications.

## BACKGROUND ART

The production of rocks for various uses, sometimes requires the rocks to be "finished". Finishing refers to putting a rock into a device, which grinds the sharp edges off rocks which forms dust which is one product and improves the shape of the rock which is another product.

Dust is a product (< 5 mm) used in asphalt, concrete aggregate and fillers.

Shaped rock is used for coarse concrete aggregate and road sealing chip.

At present there are there common types of finishing crushers available. These are cone crushers, vertical shaft impact (VSI) crushers and hammer mills, and horizontal shaft impactors (HSI).

An optimum crusher would be small, light and inexpensive. It would take a large feed and produces a small product with low power consumption. Low operating costs and a greater control over the shape of the end product would also be an advantage.

Existing VSI crushers are often so tall that they cannot be combined with other plant. For example, VSI crushers are difficult to transport as part of a road trailer.

Hammer mills and cone crushers are shorter, but are very heavy, which places limits on the transportation of the device.

It would be desirable if there could be provided a crusher of right height and weight to be transportable, yet still effective.

Another problem which needs to be addressed is finding the right crushing action.

In an anvil VSI rock crusher, the rock is thrown square at a series of flat plates called anvils. It then shatters, falls and is immediately discharged. This means that there is a high impact, but the residence time in the crushing chamber is small. There is a high reduction in size of the rock, but because there is no swirling grinding action, little dust is made. Hence the product is badly shaped. The wear rate on the anvils is also very high, increasing running costs.

In a rock on rock VSI, the rock bed consists of a live layer and a stationary layer underneath the live layer. The rock is thrown at the live layer of rock bed which is already moving rapidly in the direction of the thrown material. This means only low impact and low shattering takes place. Because the chamber is designed to retain rock it has a very long residence time and a large amount of grinding and shaping takes place.

A rock on rock VSI is often criticised for making too much dust and overshaping the rock. Overshaping is the production of rounded rocks

which present less contact area to tarseal than more cubical rock (i.e. rock that has been shaped less).

A problem with existing crushers is that often, the breakage of the rocks needs to be boosted. This is can be achieved by increasing the speed of the rotor or closing up the crusher settings (more applicable to hammer and cone crushers).

Control of the ratio of chip to dust however is limited

For existing VSI crushers to increase breakage, additional anvils can be used. But these are expensive.

What is needed then is a rock crusher that is small in size, lightweight and inexpensive to operate, and achieves greater control of the shaping of the rocks.

It is an object of the present invention to address the foregoing problems or at least to provide the public with a useful choice.

Further aspects and advantages of the present invention will become apparent from the ensuing description which is given by way of example only.

## DISCLOSURE OF INVENTION

According to one aspect of the present invention there is provided a rock crusher including a crushing chamber, a shaft,

the rock crusher characterised in that the shaft is angled with respect to the vertical.

Configuring the it is offset to the verical shaft so has advantages that will become reading apparent.

Preferably the crushing chamber of the rock crusher will be at substantially perpendicular the shaft.

It should be appreciated that the advantages of the present invention that will be alluded to further on may still be achieved if the shaft and the crushing chamber are not substantially perpendicular.

One advantage of configuring the shaft as being off-vertical allows the shaft to be configured at a reduced height and weight. This gives an advantage when the rock crusher needs to be mounted on a road trailer, or other transportation device. Existing VSI crushers and hammermills are too great in height or very heavy, posing transport limitations.

The present invention overcomes these limitations by angling the shaft as above.

Preferably, the measurable angle by which the crushing chamber and the shaft are tilted range between 1° and 30°.

At less than 1° the crusher is likely to have similar problems to VSI crushers. At greater than 30° it is possible that the live rock will damage the exterior of the rotor.

The advantages gained from angling the crushing chamber by a measurable angle from the horizontal i.e substantially perpendicular to the off-vertical shaft, can be seen when one describes the operation of an ordinary VSI rock crusher.

In a VSI rock on rock crusher, the breakage takes place in two stages. First, the rock is impelled into the crushing chamber wall where it shatters into a sharp edged particle.

Another problem is low impact occurring when the rock is impelled towards a rock bed which is already moving rapidly in the direction of the thrown material. This results in low shattering.

The particle is then carried around the crushing chamber in a tumbling action which grinds the sharp edges off, forming dust and improving the particle shape.

The best fracture is achieved with a high impact where there is a large speed difference between the rock thrown and the internal wall of the crushing chamber, which may consist of an anvil or stone bed.

The best grinding and shaping is achieved by having a long tumbling time in the crushing chamber. However, too long a tumbling time shapes a good quality cubical rock to a more spherical shape which is of poor quality. Further, the production of more spherical rocks results in excess dust being produced from the rounded edges.

In an anvil VSI, the rock is thrown square at the anvil, which may be a flat plate, where it shatters, and is immediately discharged. A high impact is achieved but there is a very small residence time in the crushing chamber. Therefore very little or no swirling grinding action takes place resulting in a badly shaped product.

The wear rate on the anvils is also very high.

With the present invention, the angled crushing chamber is designed to retain rock, but also to slow the swirling of the rock bed as much as possible, which creates the large speed difference between the rock thrown and the inside of the crushing chamber. This has an advantage of creating a large speed difference between the impelled rock and the inner wall of the rock crusher, which increases the shattering capability of the crushing chamber.

The angling of the chamber causes the depth of the rock lining about the circumference of the internal wall of the crushing chamber to vary. This breaks up the flow of the live rock bed around the inside of the chamber. The crushing chamber of the present invention achieves this because the varying rock wall depth in the chamber forms a tightening corner, and hence a rock will experience a slowing effect as it is forced around the tightened corner.

Preferably, anvils can be added to this arrangement, which will further increase breakage of rocks.

The above invention gives the advantage of having a medium to high impact, and a residence time in the crushing chamber, that gives a well crushed and well shaped product without too much dust.

In a further preferred embodiment, the crushing chamber may include a section of anvils.

The section of anvils may be positioned around the entire perimeter of the crushing chamber, but in preferred embodiments will only be positioned about a portion of the inside of the crushing chamber.

The advantage of adding a short anvil ring, is that breakage is increased, while increasing the cost by approximately a quarter of the cost of having an anvil ring around the entire perimeter of the crushing chamber. This is often the difference between whether the operation of a rock crusher is cost effective or not.

This is in contrast to the prior art. Machines that use entirely anvils to crush are also very expensive to operate due to the wear rate of the anvils. In the prior art such as a VSI crusher there is only the choice of either a set of anvils about the entire perimeter of the crushing chamber or none at all. Thus the angling of the crushing chamber allows the above advantages, which is clearly advantageous over the prior art.

Preferably, the anvil segment in the crushing chamber may be adjustable. Preferably, the adjustable factors may be the segment perimeter, the orientation with respect to the chamber and the spacing of anvils with respect to each other.

The anvil segment may be part of a carrier structure so the structure that can be repositioned, removed, or inserted into the chamber as required.

This has the advantage of increasing the efficiency of the anvils and consequently the efficiency of the rock crusher. The angle, pitch and length of the segments may be adjusted to suit the crushing and impact force required for a particular rock type.

The applicant has conducted some tests which show the advantages of the present invention and the prior art which are summarised in Table 1 below. The points given are subjective with the greater number of points, the better.

## TABLE 1

| | Possible Points | Standard Cone | Short/ Fine Cone | Rock on Rock VSI | Anvil VSI | Hammer mill/ Impactor | ASI |
|---|---|---|---|---|---|---|---|
| *Performance* | | | | | | | |
| Feed Size | 4 | 4 | 1 | 2 | 4 | 3 | 3 |
| Dust Production | 4 | 1 | 3 | 4 | 3 | 2 | 4 |
| Chip Production | 4 | 3 | 2 | 2 | 4 | 2 | 3 |
| Product Shape | 4 | 2 | 2 | 4 | 2 | 3 | 3 |
| Product Control | 4 | 2 | 2 | 2 | 2 | 2 | 4 |
| *Cost* | | | | | | | |
| Wear Rate | 6 | 6 | 5 | 6 | 1 | 1 | 3 |
| Power Consumption | 3 | 3 | 3 | 1 | 2 | 2 | 2 |
| Capital Cost | 8 | 1 | 2 | 4 | 2 | 6 | 6 |
| *Installation* | | | | | | | |
| Height | 2 | 2 | 2 | 1 | 1 | 2 | 2 |
| Weight | 2 | 1 | 1 | 2 | 1 | 2 | 2 |
| | 42 | 25 | 23 | 26 | 22 | 25 | 32 |

## BRIEF DESCRIPTION OF DRAWINGS

Further aspects of the present invention will become apparent from the following description which is given by way of example only and with reference to the accompanying drawings in which:

Figure 1 shows a side on schematic drawing of the preferred embodiment; and

Figure 2 shows a plain view of the preferred embodiment.

## BEST MODES FOR CARRYING OUT THE INVENTION

According to Figure 1 there is shown a side on view of an angled rock crusher (1) in accordance with one embodiment of the present invention.

The angled rock crusher (1) includes hopper (2), and crushing chamber (3). Feed tube (4) and rotor (5) are contained within the crushing chamber (3). Rock wall (6) and anvil set (7) are also located within the crushing chamber (3). The crushing chamber (3) includes outlet point (8). Driving mechanism (9) is also associated with the rock crusher (1).

In operation, rocks are fed from the hopper (2) into the rotor (5) via feed tube (4). The rocks are impelled to a high velocity by the rotor (5). The rocks are either impelled onto the rock wall build up (6) on the wall of rock crushing chamber (3) or impact against the anvil set (7). After this process, the rock particles are removed from the crushing chamber (3) via outlet (8). The rotor (5) may be driven by driving mechanism (9) which may be a vee belt.

With reference to Figure 2, it can be seen how the rock wall (6) does not form all the way around inside the wall of the crushing chamber (3). The

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build up is uneven, causing an acceleration towards the anvils (7).

Aspects of the present invention have been described by way of example only and it should be appreciated that modifications and additions may be made thereto without departing from the scope thereof.

**Rocktec Limited**

**by their Attorneys**

Denise Harding

**JAMES & WELLS**